

LEVEL II

12



Rockwell International

MRDC41081.1RD

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1980

ARPA ORDER NO.: 4036

CONTRACTOR: Rockwell International/MRDC

CONTRACT NO. 15 N00173-80-C-0485

CONTRACT AMOUNT: \$350,000

EFFECTIVE DATE OF CONTRACT: 09/18/80

EXPIRATION DATE OF CONTRACT: 11/17/81

PRINCIPAL INVESTIGATOR: 10 P. D. /Dapkus

TELEPHONE NO.: 805/498-4545

SHORT TITLE OF WORK: Integrated Optical Transmitter and Receiver

REPORTING PERIOD: 09/18/80 through 12/31/80

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SELECTED
APR 28 1981

A. DESCRIPTION OF PROGRESS:

Most of the effort during this quarter was devoted to the development of the diffusion process required for the TJS laser and to definition of epitaxial growth and process requirements to achieve the program goals.

Laser Development

During this reporting period, deep Zn diffusion process for producing a transverse junction in the proposed laser structure was studied and developed.

A two-step diffusion process was used in this work. Zn was first introduced to the sample via vapor phase of ZnAs₂ in a sealed quartz ampul. Diffusion was carried out at 650-700°C and quenched off at the end of the diffusion period. The measured diffusion depths followed the Fick's law. At 650°C, the diffusion rates in GaAs and Ga_{0.7}Al_{0.3}As were 1.4 $\mu\text{m-hr}^{1/2}$ and 1.6 $\mu\text{m-hr}^{1/2}$, respectively. The above diffusion produced a very abrupt junction and had a surface concentration of $\sim 10^{20} \text{ cm}^{-3}$. This layer of diffused Zn then served as a source for the second drive-in diffusion. The second diffusion was performed at 850-900°C in a flowing H₂ atmosphere.

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The laser double heterostructures were grown by MO-CVD at a temperature of 750°C. They consisted of 1.5 μm Se doped ($\sim 10^{18} \text{ cm}^{-3}$) $\text{n-Ga}_{0.7}\text{Al}_{0.3}\text{As}$ confinement layers, a 0.3 μm Se doped ($\sim 10^{18} \text{ cm}^{-3}$) n-GaAs active layer, and a 0.2 μm Se doped ($\sim 10^{18} \text{ cm}^{-3}$) n-GaAs cap layer. After growth, plasma enhanced CVD Si_3N_4 was deposited on the wafer as a diffusion mask. Then parallel stripes for diffused region were etched in it. Diffusion was made at 650°C for 30 minutes and for the second step drive-in at 850°C for four hours. For metallization, Au-Ge Ni Au was used for n contact, and Cr Au Schottky metal was deposited on the diffused side. The diodes were then bonded junction-side up on a TO header. The room temperature (23°C) pulsed threshold of 200 μm length devices were $\sim 140 \text{ mA}$. External differential quantum efficiency was 15% per facet. They did not exhibit single mode oscillation, and the light was emitted at an angle of 20° to the facet norm.

Possible causes for these results were investigated. For example, the layer dopings and resistances were not optimized according to our calculation. The redistribution of Cr in the original S. I. substrate after heat treatment is also thought to affect the properties of the material. In the next quarter, continued efforts to improve the TJS laser performance will be undertaken.

Process Development

Alternatives for incorporation of the epitaxial structure on a semi-insulating substrate for the transmitter were studied. A mesa approach was eliminated owing to the difficulty of achieving fine gate geometries on a wafer with 3 μm high mesas. An alternative in which epitaxial growth in a groove followed by an etch to achieve a planar buried structure was chosen. Experiments will commence next quarter to demonstrate this process.

B. CHANGE IN KEY PERSONNEL:

Dr. Michael Kim has joined the program and will be responsible for chip design and electronic device design and testing. Dr. Kim has been a member of the Electro Optics Department of Rockwell's Science Center for two years where he has been involved in the development of HgCdTe CCD's.



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C. SUMMARY OF SUBTANTIVE INFORMATION DERIVED FROM SPECIAL EVENTS:

Nothing to report.

D. PROBLEMS ENCOUNTERED AND/OR ANTICIPATED:

Nothing to change program direction.

E. ACTION REQUIRED BY THE GOVERNMENT:

None.

F. FISCAL STATUS:

- (1) Amount currently provided on contract: \$350,000
- (2) Expenditures and commitments to date: 42,900
- (3) Funds required to complete work: 307,100

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Rockwell
International

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Att: Program Management

Re: R & D Status Report No. 1
For period 09/18/80 thru 12/31/80
Document No. MRDC41081.1RD

In accordance with the requirements stated for Contract No. N00173-80-C-0485, ARPA Order No. 4036, enclosed herewith is R & D Status Report No. 1.

ROCKWELL INTERNATIONAL
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